Electronic Supplementary Information

Boosting Oxygen Evolution Reaction in Non-Precious Catalyst by Structural and Electronic Engineering

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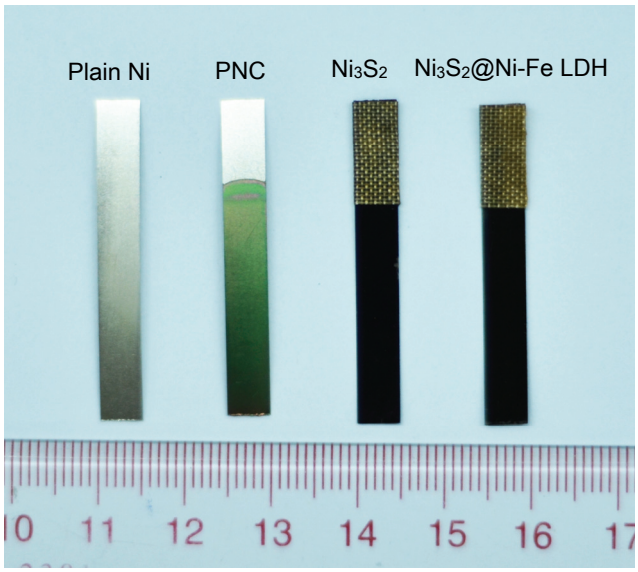

Fig. S1. Optical image of plain nickel, anodic nickel (PNC), Ni_3S_2 nanorods and Ni_3S_2 nanorod@Ni-Fe LDH nanofilm

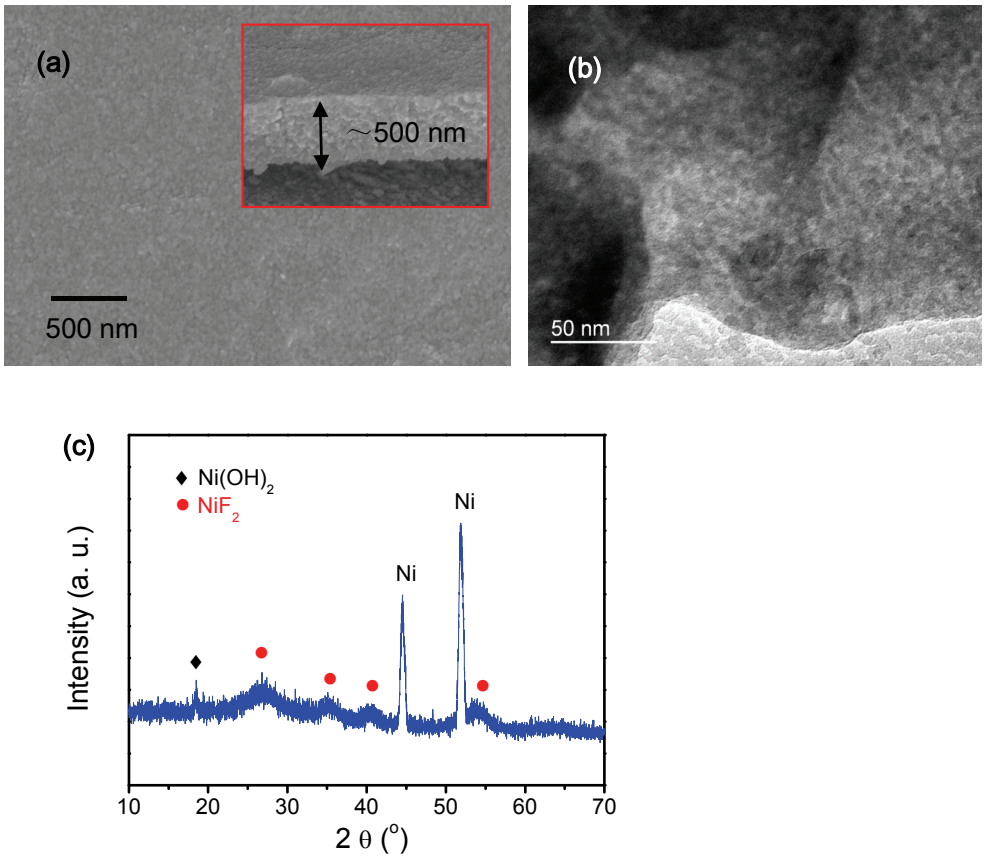

Fig. S2. (a) SEM, (b) TEM and (c) XRD of PNC

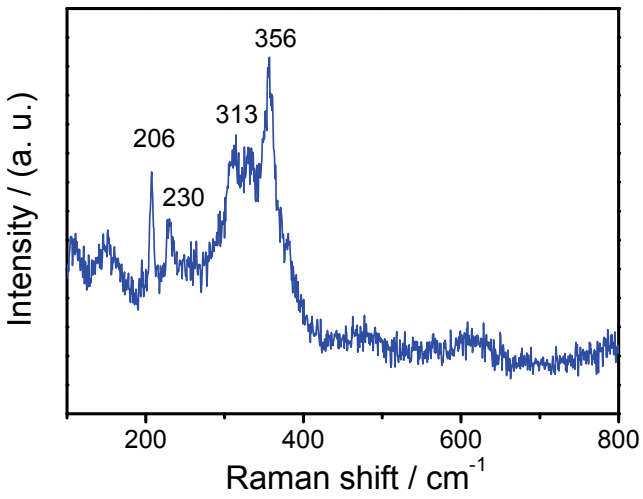

Fig. S3. Raman spectrum of vertically aligned Ni_3S_2 nanorods.

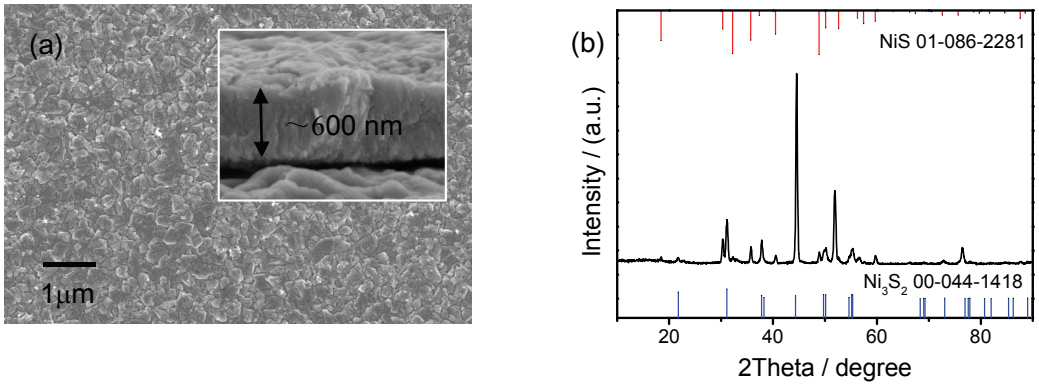

Fig. S4. (a) SEM and (b) XRD of plain nickel subject to sulfidization without additional nickel salts.

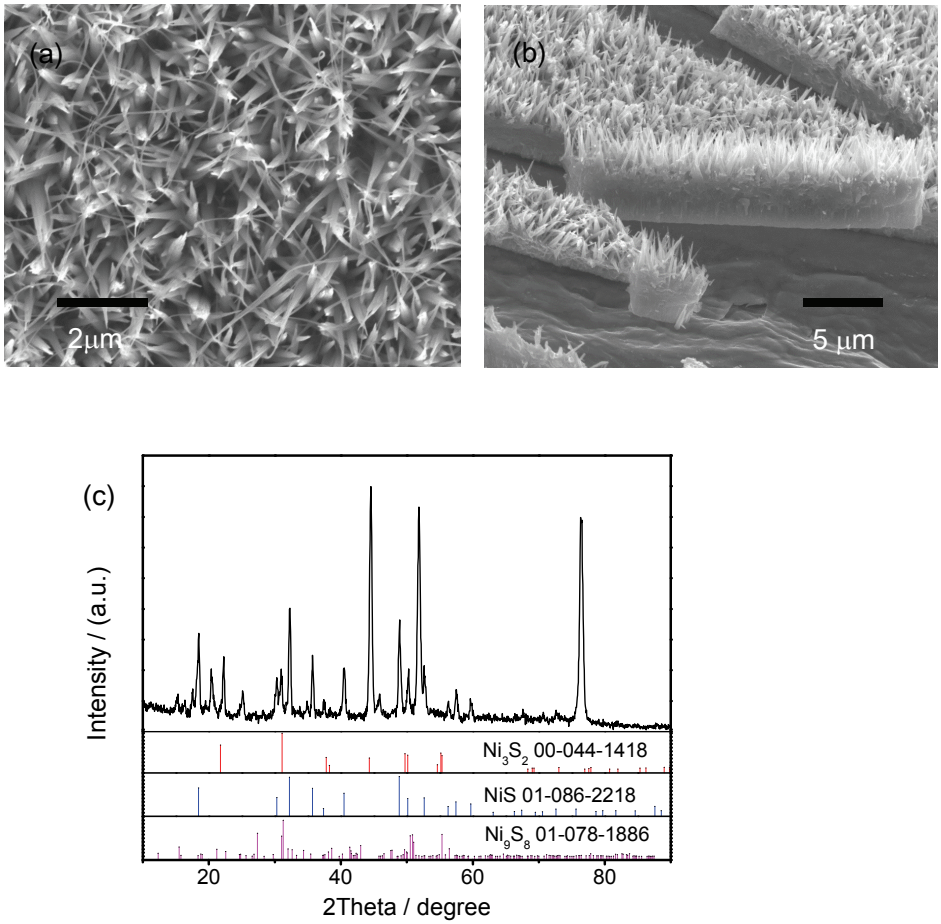

Fig. S5. (a) Top view and (b) cross section view SEM images, and (c) XRD of Ni_3S_2 nanowire obtained from sulfidization of plain nickel with additional nickel salts.

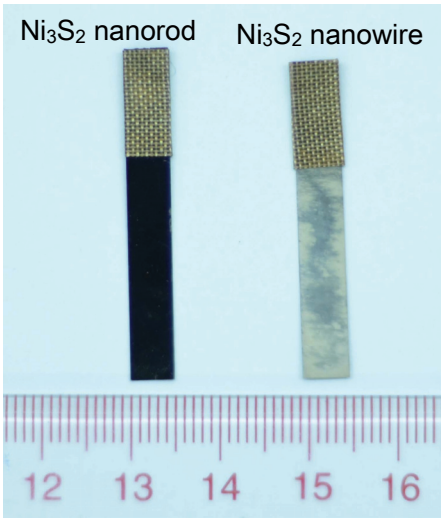

Fig. S6. Optical image of the sample after 10 min ultrasonic treatment in deionized water.

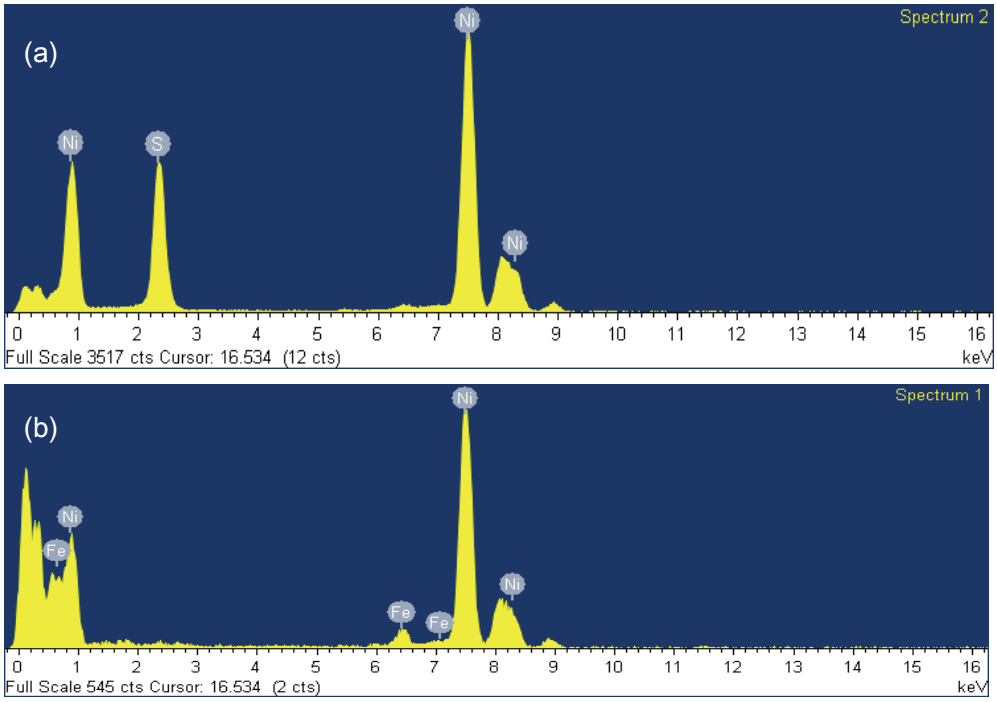

Fig. S7. The energy dispersive X-ray spectroscopy (EDX) of (a) Ni_3S_2 nanorod and (b) Ni-Fe LDH nanofilm.

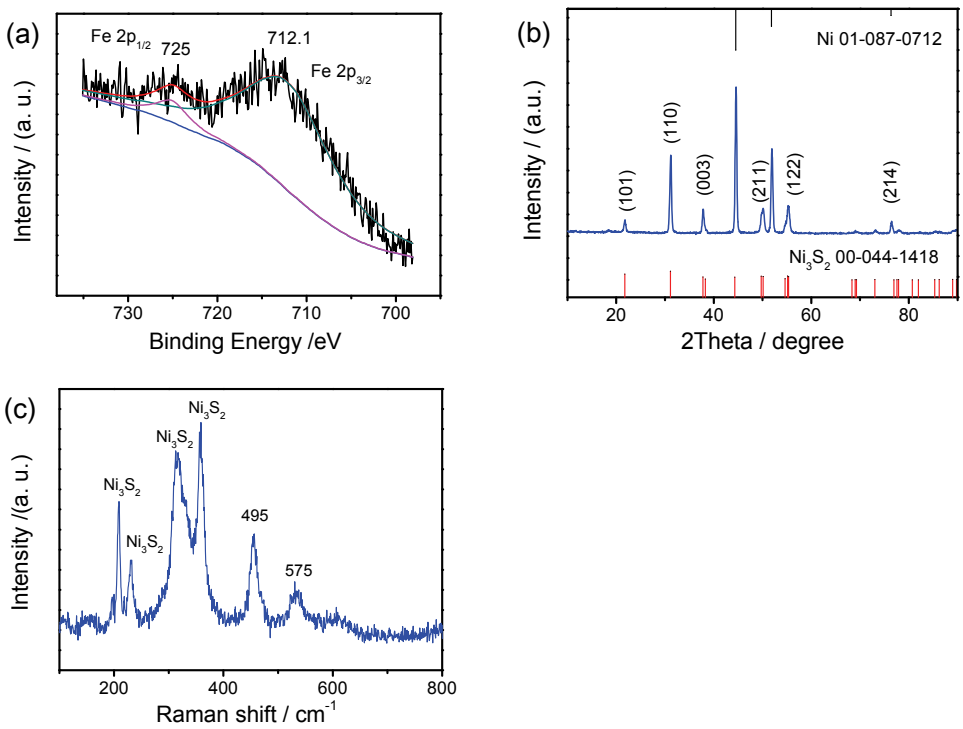

Fig. S8. (a) Fe 2p XPS, (b) XRD and (c) Raman spectra of Ni_3S_2 nanorod@Ni-Fe LDH nanofilm.

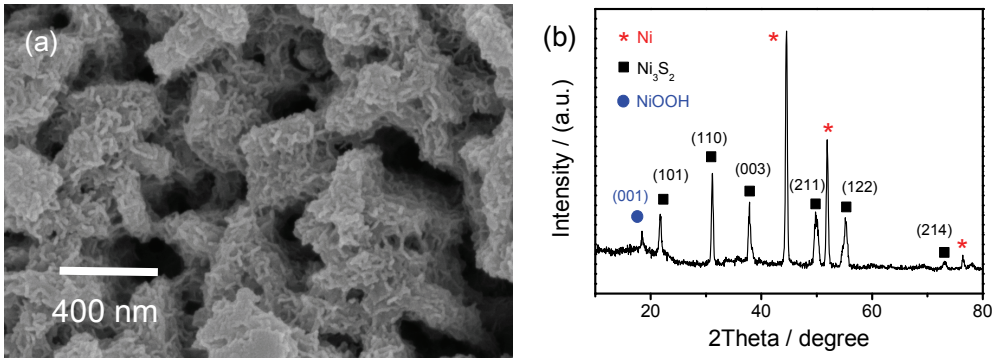

Fig. S9. (a) SEM image and (b) XRD of Ni_3S_2@Ni-Fe LDH after 40 hours' water electrolysis.

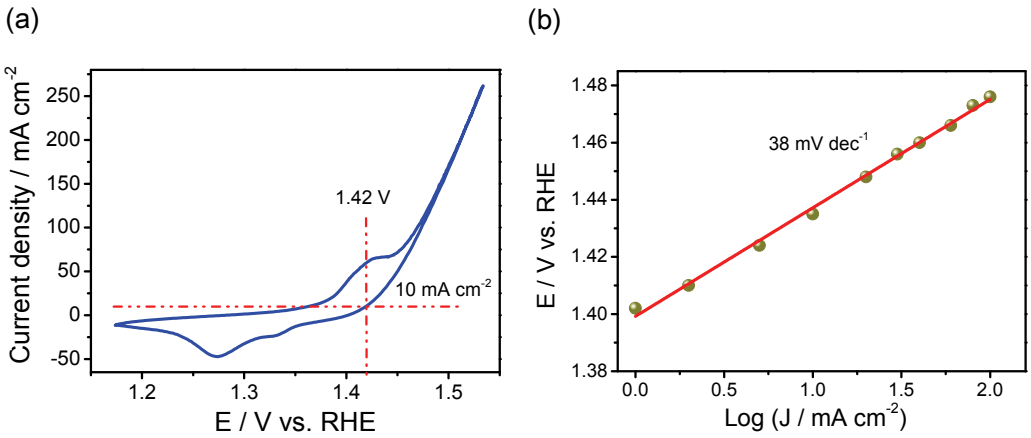

Fig. S10. (a) CV and (b) Tafel plot of Ni3S2@Ni-Fe LDH prepared on nickel foam in 1M KOH. CV Scan rate: 1 mV s^{-1}.

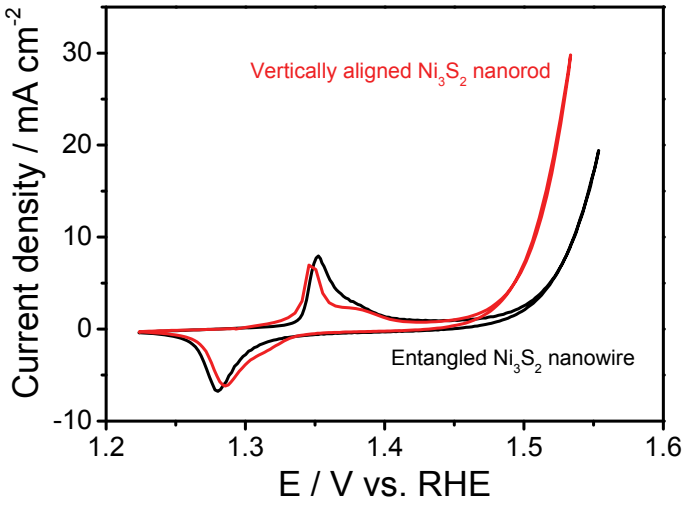

Fig. S11. CV plot of two kinds of Ni_3S_2 in 1M KOH. Scan rate: 1 mV s^{-1}.

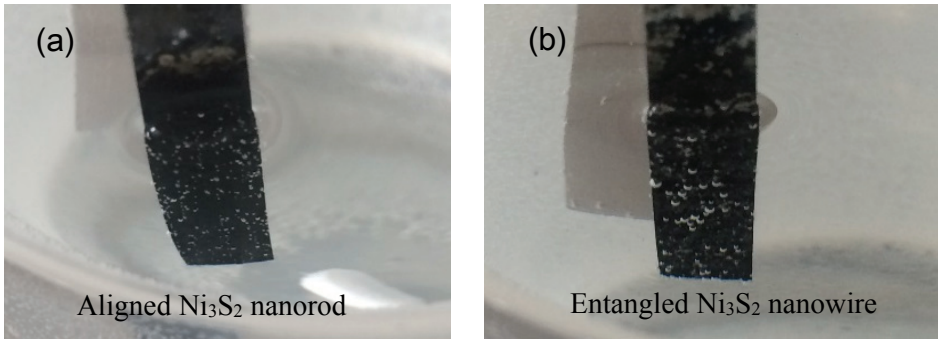

Fig. S12. Optical image of water electrocatalysis at the current density of 10 mA cm^{-2}, (a) aligned Ni_3S_2 nanorods and (b) entangled Ni_3S_2 nanowires. Electrolyte: 1 M KOH.

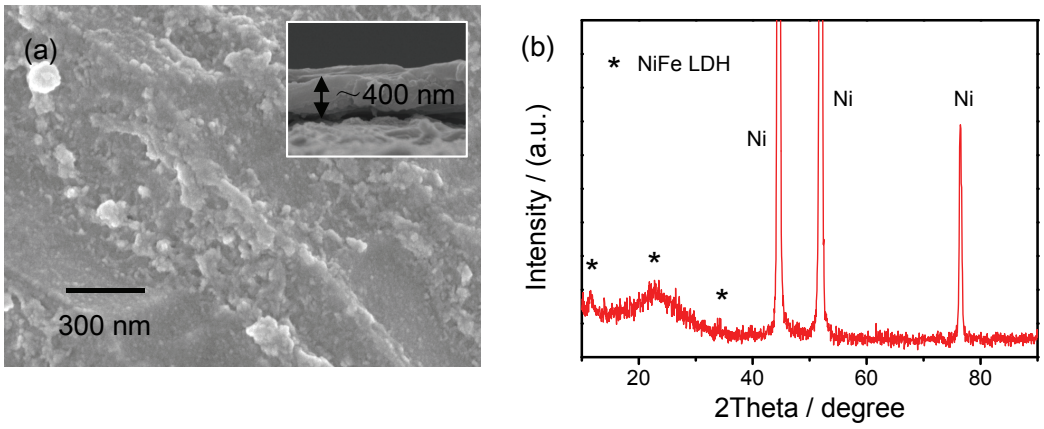

Fig. S13. (a) SEM and (b) XRD of Ni@Ni-Fe LDH.

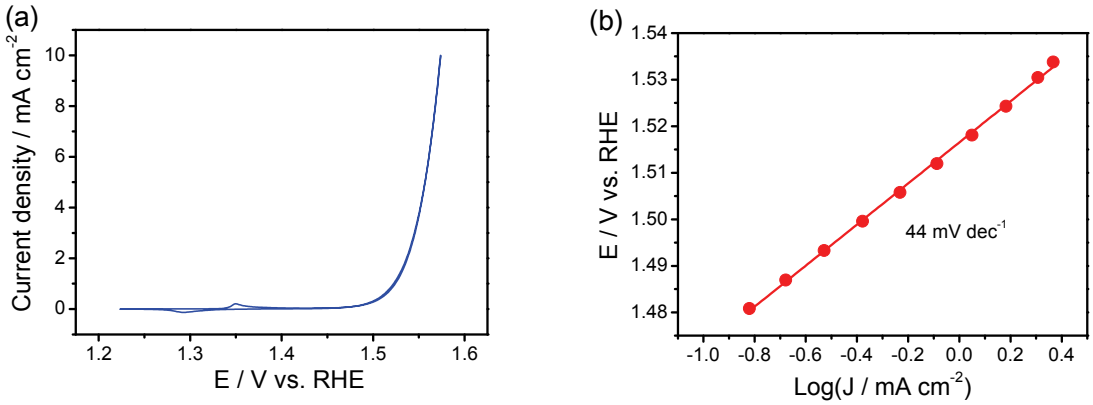

Fig. S14. (a) CV and (b) Tafel plot of Ni@Ni-Fe LDH in 1M KOH. CV Scan rate: 1 mV s^{-1}.

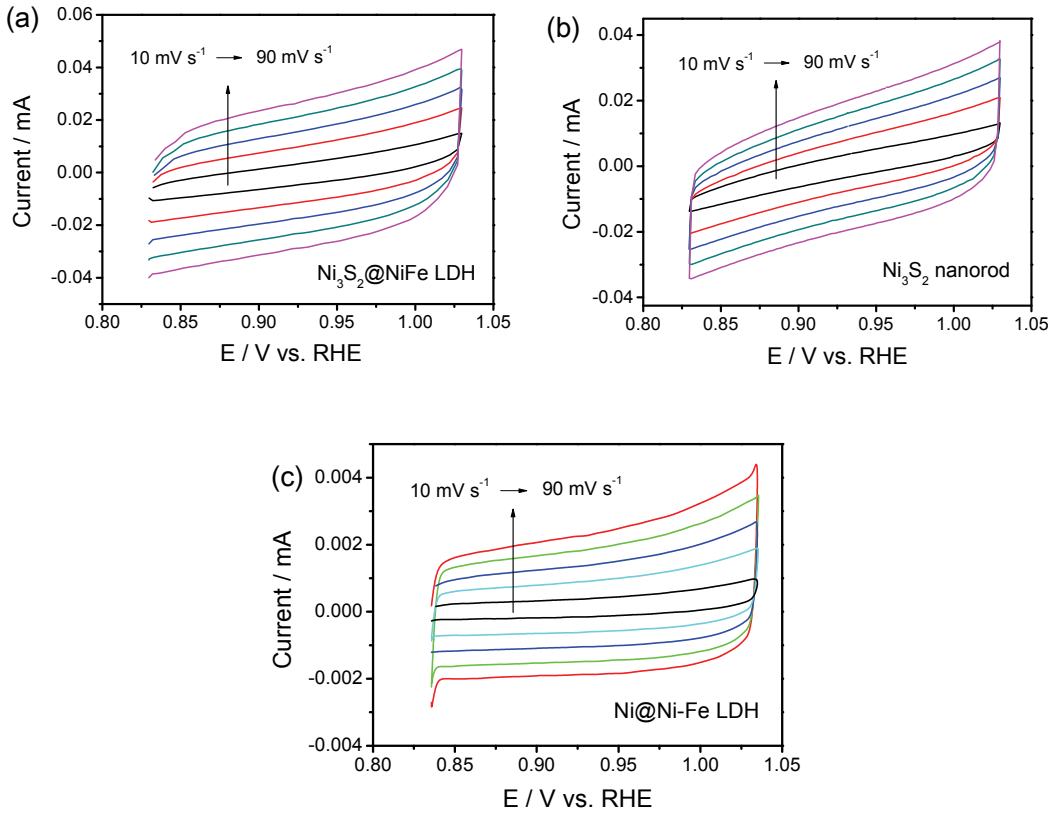

Fig. S15. The variation of scan rate with current density in the potential range where no Faradaic processes occur. (a) Ni_3S_2 nanorods, (b) Ni_3S_2@Ni-Fe LDH, (c) Ni@Ni-Fe LDH.

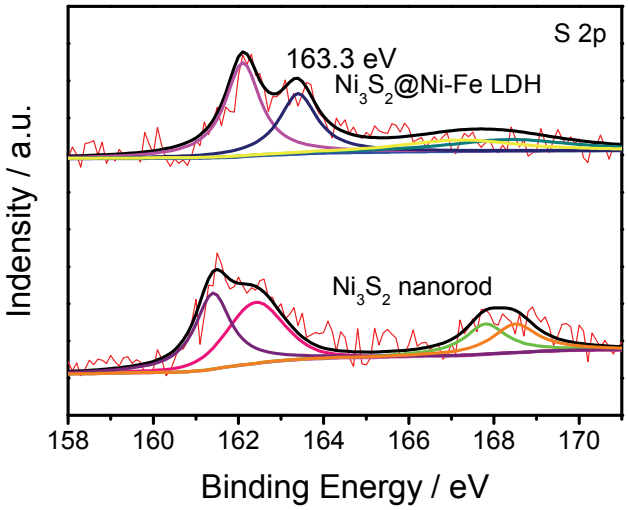

Fig. S16. S 2p XPS spectra of Ni_3S_2@Ni-Fe LDH and Ni_3S_2 nanorod.

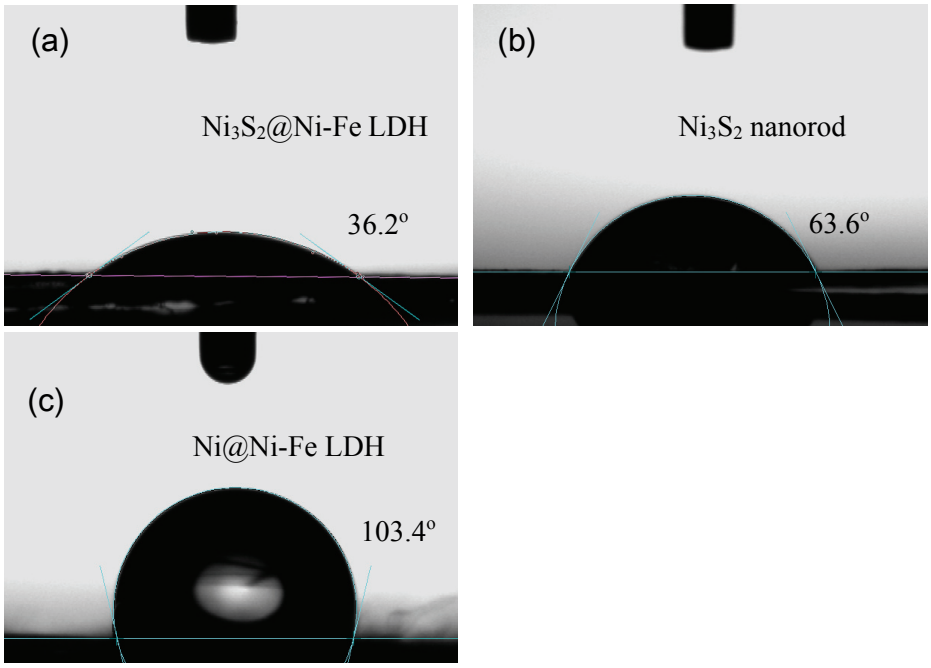

Fig. S17. Contact angle of (a) Ni_3S_2@Ni-Fe LDH, (b) Ni_3S_2 nanorod and (c) Ni@Ni-Fe LDH.

Table S1. Performance comparison between Ni3S2@Ni-Fe LDH and recently reported non precious OER catalysts.

Material	**Solution**	**Current collector**	**OverPotential @ 10mA/cm^2 mV**	**Tafel slope**	**Reference**
Ni_3S_2@NiFe LDH	1M KOH	Planar, nickel foil	245	**35**	**This work**
		3D, nickel foam	190	**38**	
CoNi(20:1)-P-NS[1]	1M KOH	Glassy carbon	273	45	Energy Environ. Sci., 2017
		3D, nickel foam	209	52	
$Na_{0.08}Ni_{0.9}Fe_{0.1}O_2$[2]	1M KOH	Glassy carbon	260	40	Energy Environ. Sci., 2017
FeNi-LDH /Ti_3C_2-MXene[3]	1M KOKH	Glassy carbon	298	43	Nano Energy, 2018
CoOx[4]	1M KOH	Glassy carbon	306	65	Nano Energy, 2018
CoO_x/BNG[5]	0.1M KOH	Glassy carbon	295	57	Angew. Chem. Int. Ed., 2017
pc-Ni-Bi@NB[6]	1M KOH	Glassy carbon	302	52	Angew. Chem. Int. Ed., 2017
$Ni_xCo_{1-x}O$[7]	0.5M KOH	Planar, gold	350		Adv. Funct. Mater. 2017
Fe_3N/Fe_4N[8]	1M KOH	3D, nickel foam	238	44.5	ACS Catalysis 2017
NiO/CoN[9]	1M KOH	Carbon fiber paper	300	35	ACS Nano, 2017
Fe_1Co_1-ONS[10]	0.1M KOH	Glassy carbon	308	36.8	Adv. Mater. 2017
NiFe-MOF[11]	0.1M KOH	3D, Ni foam	240	34	Nat. Commun., 2017
$Ni(OH)_2$-Au[12]	1M KOH	Glassy carbon	270	35	J. Am. Chem. Soc., 2016
NiFe-NS[13]	1M KOH	glassy carbon	302	40	Nat. Commun., 2014
NiFe/NiFe:Pi[14]	1M KOH	3D, carbon fiber paper	290	38	ACS Catalysis 2017
CoFe LDH-Ar[15]	1M KOH	Glassy carbon	266	37.85	Angew. Chem. Int. Ed., 2017

$(Co_{0.25}Fe_{0.48})_2P$ [16]	1M KOH	Co-Fe-P ribbon	270	30	Energy & Environ. Sci. 2016
MoS_2-Ni_3S_2 [17]	1M KOH	3D, Ni foam	249	57	ACS Catalysis 2017
$FeNi_8Co_2$ LDH[18]	1M KOH	3D, Ni foam	230	42	Chem. Commun. 2015
Carbon-coated Ni-Co nanowier[19]	1M KOH	Carbon fiber fabric	302	43.6	Adv. Energy Mater. 2016
Mono NiTi MMO[20]	1M KOH	Glassy carbon electrode	320	52	J. Am. Chem. Soc. 2016
$\beta Ni(OH)_2$/O-MWCNT[21]	1M KOH	Glassy carbon electrode	270	32	Adv. Energy Mater. 2016
Ni_3FeN nanoparticle[22]	1M KOH	Glassy carbon electrode	280		Adv. Energy Mater. 2016
Fe_3O_4@Co_9S_8/rGO[23]	1M KOH	Glassy carbon	320	54.5	Adv. Funct. Mater. 2016
NiCo LDH [24]	0.1 M KOH	3D, Ni foam	420	113	J. Power Sources 2015
NiCo LDH[25]	1M KOH	Carbon paper	367	40	Nano Lett. 2015
Fe-N-C/NiFe-LDH[26]	0.1M KOH	Rotating disk electrode	285		Energy & Environ. Sci. 2016
$NiCo_2S_4$ NW/NF[27]	1M KOH	3D, Ni foam	260	40.1	Adv. Funct. Mater. 2016
NiSx[28]	1M KOH	Glassy carbon electrode	353	41	Chem. Mater. 2016

Table S2. Electrical elements of Ni_3S_2 and Ni_3S_2@Ni-Fe LDH fitted by the equivalent circuit as shown in the inset of Fig. 5a.

	R_s / Ω	CPE_1 / mF	R_{ct} / Ω	CPE_2/ mF	R_{OER} /Ω
Ni_3S_2	0.715	270	0.165	818	3.516
Ni_3S_2@Ni-Fe LDH	0.612	286	0.269	486	1.214
Ni@Ni-Fe LDH	0.787	11	25.2	66	14.2

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